FEB107-001 User's Guide
240W PFC/PWM Combo Evaluation Board

Featured Fairchild Product: FAN4803

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1. General Board Description

The FEB107-001 Evaluation Board is a power factor corrected 12V 20A off-line power supply. It is designed to meet IEC1000-3-2 over the universal input voltage range of 85 to 265VAC. The Evaluation Board demonstrates that the FAN4803 can be designed with a low cost single sided PCB at a power level, size, and cost that is compatible with most desk top computer power supply requirements. The FAN4803 is the replacement for the ML4803, but either IC will work with this board.

1.1 Contents of FEB107-001 Evaluation Kit

- FEB107-001 Evaluation Board
- FEB107-001 Evaluation Kit User's Guide
- CD ROM containing the following
  - FEB107-001 Evaluation Kit Users Guide
  - FAN4803 Data Sheet
  - Additional Fairchild data sheets for parts listed on the Bill of Materials
  - **Application Note AN-42043 -** ML4803 240W Off-Line Power Supply with PFC
  - **Application Note AN-42047 -** Power Factor Correction (PFC) Basics

1.2 Power Supply Specification Table

Description	Condition	Min	Typ	Max	Units
Input Voltage (V_{IN})		85		265	VAC
Output Voltage 1 (V_{OUT})			12.0		V
Output Current 1 (I_{OUT})			20		A
Power	120 V_{AC}		290		W
Efficiency	120 V_{AC}		81		%
Power Factor	120 V_{AC}		.98		

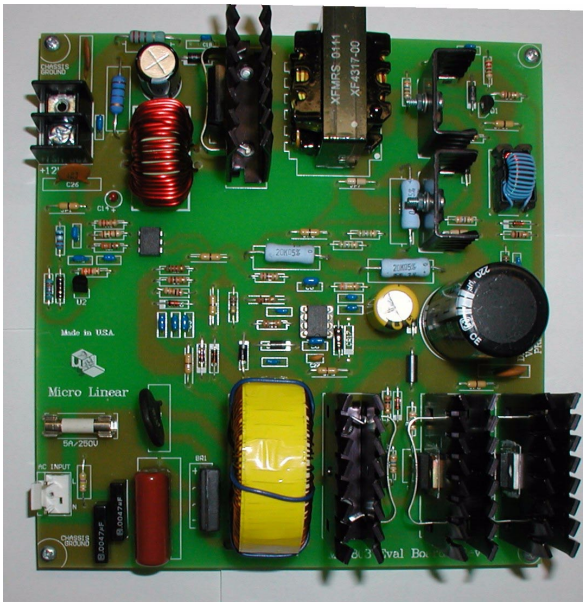


Figure 1. Photograph of evaluation board

1.3 FEB107-001 Schematic

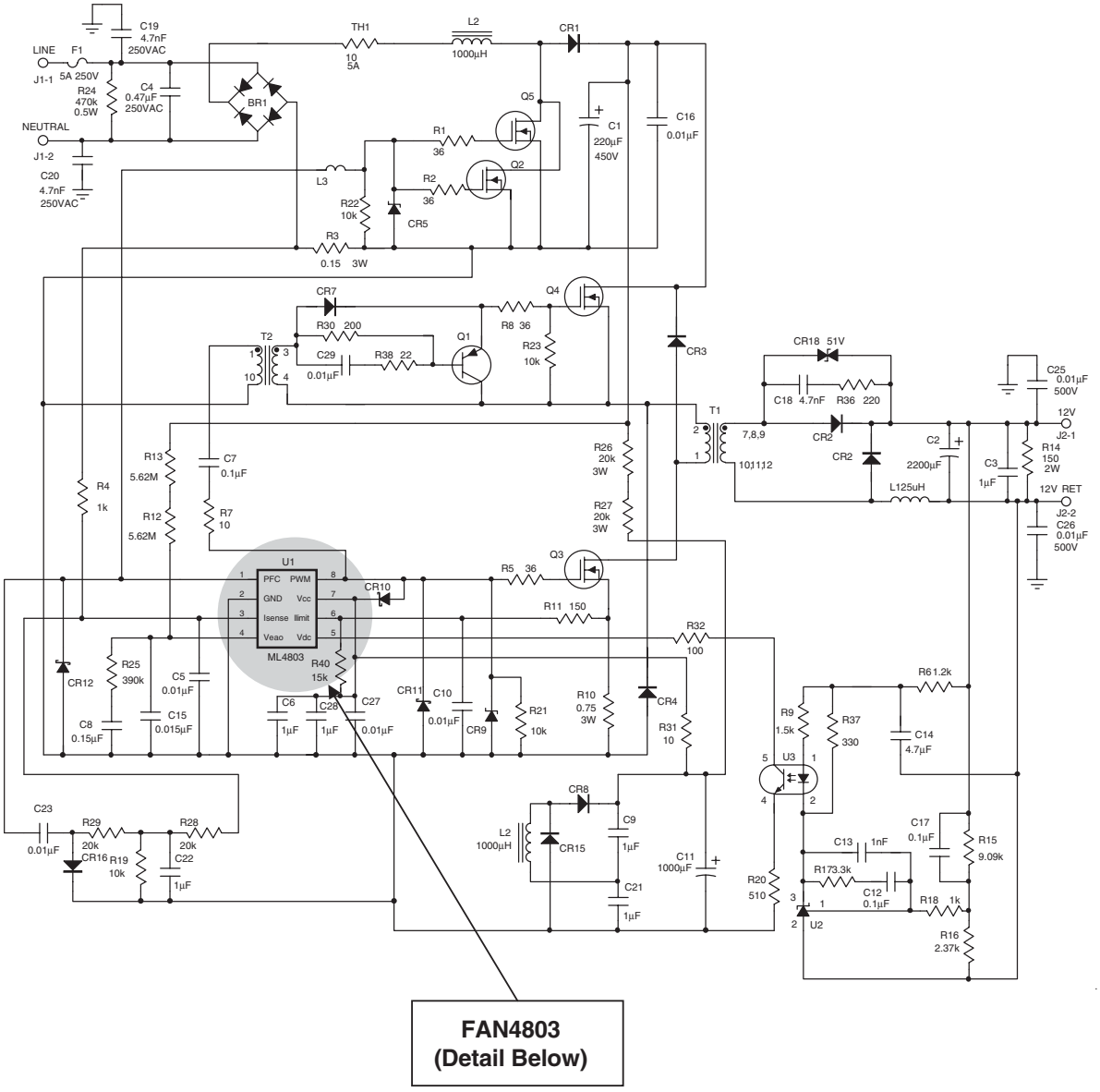


Figure 2. FEB107-001 Schematic

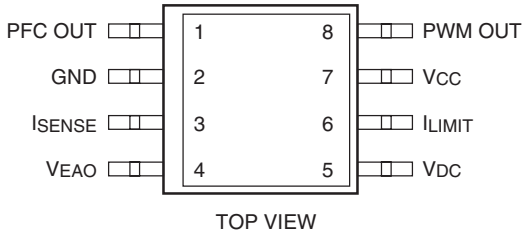


Figure 3. FAN4803 Pin Configuration

2. Test Procedure

Caution

The FEB107-001 Evaluation Board contains voltage potentials capable of causing serious injur y, and components which, if failing, may shatter or explode. Please use extreme caution when operating this board. The use of protective wear is strongly recommended. To safely observe in-circuit waveforms an isolation transformer should be inserted between the AC line and the Board. Do not operate this Board with AC voltages outside the design limits. When replacing components on this Evaluation Board use only those shown in the following parts list.

Use the following procedure to safely operate the power supply.

1. Connect a load (active or resistive) to the output terminals. Set the load to zero amps.
2. Connect a DC voltmeter across the output terminals.
3. Connect an isolated variable AC source (such as a Variac) to the AC input connector (Line and Neutral), with the voltage initially set to zero.
4. Adjust the AC input voltage within the range of 85 to 265VAC.
5. The output voltage should read 12VDC ±1%.
6. Increase the load to 19.5A. The output, as measured at the output terminals, should regulate within ±0.1% of the nominal reading. The ripple voltage should read less than 30mV RMS.
7. The input power factor should be greater than 0.95. Efficiency should be greater than 80%.
8. Reduce the AC input to zero and verify that the output voltage drops to zero.

3. Test Results

3.1 Performance Data

To measure the Evaluation Board performance across the range of permissible input voltages use an isolated Variac or adjustable AC source. A typical FEB107-001 Evaluation Board will have the performance characteristics shown in Table 1 when operated under the test conditions listed.

Table 1: Performance data

Input:	85VAC	120VAC	230VAC	265VAC	Units
Efficiency	63	81	68	82	%
P. F.	0.99	0.98	0.96	0.97	n.a.
Power	50	290	50	290	W

3.2 Power Ratings

The FEB107-001 Evaluation Board is designed to deliver up to 240 Watts at 85VAC when used with a properly rated and positioned cooling fan. The power rating without a fan is limited to 150 Watts. A 12V fan can be placed as suggested in Figure 1 and operated from the evaluation board 12V output.

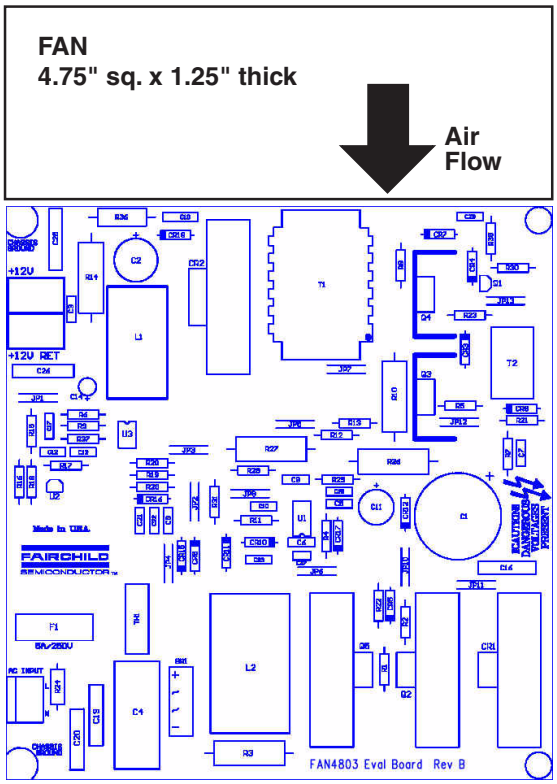


Figure 4: Fan Position

4. FEB107-001 Evaluation Kit Parts List

Item	Description	Qty	Ref.	Vendor	Part Number
Resistors					
1	Resistor 36 Ohm, 5%, 0.25W, Thru Hole	4	R1, R2, R5, R8	Mouser	30BJ250-36 / any
2	Resistor 0.15 Ohm, 5%, 3W, Wirewound, Thru Hole	1	R3	Huntington Electric Ohmite	ALSR-3J-.15 23JR15
3	Resistor 1 K, 5%, 0.25W, Thru Hole	2	R4, R18	Mouser	29SJ250-1k / any
4	Resistor 1.2 Ohm, 5%, 0.25W, Thru Hole	1	R6	Any	
5	Resistor 10 Ohm, 5%, 0.25W, Thru Hole	2	R7, R31	Mouser	30BJ250-10 / any
6	Resistor 1.5 K, 5%, 0.25W, Thru Hole	1	R9	Mouser	29SJ250-1.5k / any
7	Resistor 0.75 Ohm, 5%, 3W, Metal Oxide Film, Thru Hole	1	R10	Panasonic	ERX-3SJR75
8	Resistor 150 Ohm, 5%, 0.25W, Thru Hole	1	R11	Mouser	29SJ250-150 / any
9	Resistor 5.62 M, 1%, 0.25W, Thru Hole	2	R12, R13	Dale	CMF-55-5.62MΩ / or equivalent
10	Resistor 150 Ohm, 5%, 2W, Metal Oxide Film, Thru Hole	1	R14	Yageo Panasonic	RSF200JB-150R ERG-2SJ151
11	Resistor 9.09 K, 1%, 0.25W, Metal Film, Thru Hole	1	R15	Mouser	29MF250-9.09k / any
12	Resistor 2.37 K, 1%, 0.25W, Metal Film, Thru Hole	1	R16	Mouser	29MF250-2.37k / any
13	Resistor 3.3 K, 5%, 0.25W, Thru Hole	1	R17	Mouser	29SJ250-3.3k / any
14	Resistor 10 K, 5%, 0.25W, Thru Hole	4	R19, R21, R22, R23	Mouser	29SJ250-10k / any
15	Resistor 510 Ohm, 5%, 0.25W, Thru Hole	1	R20	Mouser	29SJ250-510 / any
16	Resistor 470 K, 5%, 0.5W, Thru Hole	1	R24	Mouser	29SJ500-470k / any
17	Resistor 390 K, 5%, 0.25W, Thru Hole	1	R25	Mouser	29SJ250-390k / any
18	Resistor 20 K, 5%, 3W, Metal Oxide Film, Thru Hole	2	R26, R27	Panasonic	ERG-3SJ203
19	Resistor 20 K, 5%, 0.25W, Thru Hole	2	R28, R29	Mouser	29SJ25-20k / any
20	Resistor 200 Ohm, 5%, 0.25W, Thru Hole	1	R30	Mouser	29SJ250-200 / any
21	Resistor 100 Ohm, 5%, 0.25W, Thru Hole	1	R32	Mouser	29SJ250-100 / any
22	Resistor 220 Ohm, 5%, 1W, Metal Oxide Film, Thru Hole	1	R36	Panasonic Yageo	ERG-1SJ221 RSF100JB-220R
23	Resistor 330 Ohm, 5%, 0.25W, Thru Hole	1	R37	Mouser	29SJ250-330 / any
24	Resistor 22 Ohm, 5%, 0.25W, Thru Hole	1	R38	Mouser	30BJ250-22 / any
25	Resistor 15 K, 5%, 0.25W, Thru Hole	1	R40	Mouser	30BJ250-15k / any
26	Resistor 0 Ohm Jumper	11	JP1 - JP11	DigiKey Yageo	0.0QBK-ND ZO-1/4W-B

FEB107-001 Evaluation Kit Parts List (continued)

Item	Description	Qty	Ref.	Vendor	Part Number
27	Thermistor 10 Ohm, 5A RMS, Thru Hole - Disc	1	TH1	DigiKey ThermoDisc THERMOMETRICS, INC.	KC006L-ND F503EL CL-50
Capacitors					
28	Capacitor 220µF, 20%, 450VDC, Electrolytic, Radial	1	C1	Panasonic	ECO-S2WB221CA
29	Capacitor 2200µF, 20%, 16VDC, Electrolytic, Radial	1	C2	Panasonic	ECA-1CFQ222
30	Capacitor 1µF, 20%, 50VDC, Z5U, Radial	5	C3, C6, C9, C21, C22	Panasonic	ECU-S1H105MEB
31	Capacitor 0.47µF, 20%, 250VDC, Film, Radial	1	C4	Panasonic	ECQ-E2A474MW
32	Capacitor 0.01µF, 20%, 50VDC, Z5U, Radial	3	C5, C23, C29	Panasonic	ECU-S1H103MEB
33	Capacitor 0.1µF, 20%, 50VDC, Z5U, Radial	3	C7, C12, C17	Panasonic	ECU-S1H104MEB
34	Capacitor 0.15µF, 10%, 100VDC, X7R, Radial	1	C8	Panasonic	ECU-S1H154KBB
35	Capacitor 0.01µF, 10%, 50VDC, X7R, Radial	1	C10	Panasonic	ECU-S1H103KBA
36	Capacitor 1000µF, 20%, 25VDC, Electrolytic, Radial	1	C11	Panasonic	ECA-1EM102
37	Capacitor 1nF, 10%, 100VDC, X7R, Radial	1	C13	Panasonic	ECU-S1H102KBB
38	Capacitor 4.7nF, 10%, 25VDC, Film, Radial	1	C14	Panasonic	ECS-F1EE475K
39	Capacitor 15nF, 10%, 100VDC, X7R, Radial	1	C15	Panasonic	ECU-S1H153KBB
40	Capacitor 0.01µF, 10%, 500VDC, Ceramic, Radial	3	C16, C25, C26	Panasonic	ECK-D2H103KB5
41	Capacitor 4.7nF, 10%, 100VDC, X7R, Radial	1	C18	Panasonic	ECU-S1H472KBB
42	Capacitor 4.7nF, 10%, 250VDC, Film, Radial	2	C19, C20	Panasonic	ECQ-U2A472MV
43	Capacitor 0.01nF, 10%, 25VDC, Ceramic, Radial	1	C27	Panasonic	ECK-F1E103ZV
44	Capacitor 1µF , 25VDC, Z5U, 1206 - Surface Mount	1	C28	Any	
Semiconductors					
45	Bipolar Transistor PNP, TO-92, FSID: 2N3906	1	Q1	Fairchild	2N3906
46	MOSFET 0.85Ohm, 500V, TO-220	4	Q2, Q3, Q4, Q5	Fairchild Fairchild	HGTP3N60A4D IRF840B
47	Diode Bridge Rectifier, 600V, 4A , KBL, FSID: KBL06	1	BR1	Fairchild	KBL06
48	Diode HyperFast, 600V, 4A, 20ns, TO-220AC, FSID: ISL9R460P2	1	CR1	Fairchild	ISL9R460P2

FEB107-001 Evaluation Kit Parts List (continued)

Item	Description	Qty	Ref.	Vendor	Part Number
49	Diode Schottky, 60V, 30A , TO-247, FSID: MBR3060PT	1	CR2	Fairchild	MBR3060PT
50	Diode Ultra-Fast, 600V, 1A, 75ns, DO-41, FSID: UF4005	2	CR3. CR4	Fairchild	UF4005
51	Diode Zener, 16V, 0.5W , DO-35, FSID: 1N5246B	2	CR5, CR9	Fairchild	1N5246B
52	Diode Schottky, 30V, 1A , DO-41, FSID: 1N5818	4	CR7, CR10, CR11, CR12	Fairchild	1N5818
53	Diode Signal, 75V, W , DO-35, FSID: 1N4148	3	CR8, CR15, CR16	Fairchild	1N4148
54	Diode Transorb, 51V, W , DO-15, FSID: P6KE51CA	1	CR18	Fairchild	P6KE51CA
55	IC PFC/PWM Combo, DIP, FSID: FAN4803CP-1	1	U1	Fairchild	FAN4803CP-1
56	IC Shunt Regulator, TO-92, FSID: TL431CLP	1	U2	Fairchild	TL431CLP
57	IC Optolsolator, DIP-6, FSID: MOC8102	1	U3	Fairchild Fairchild	MOC8102 MOC8112
Magnetics					
58	Inductor 91µH, MicroMetals Powered Iron	1	L1	Premier Magnetics	TSD-1273
59	Inductor 1.7mH, MicroMetals Powered Iron	1	L2	Premier Magnetics	TSD-1274
60	Ferrite Bead	1	L3	Panasonic	EXC-ELSA39
61	Transformer 100µH	1	T1	XFMRS, Inc.	XF4317-00
62	Transformer - Gate Drive 450µH, 1:1:1	1	T2	Pulse Engineering	P0584
Hardware					
63	Fuse 5 A, 250 VAC, 5 x 20 mm	1	F1	Littlefuse DigiKey	Series 216 F921-ND
64	Hardware Fuse Clips, PC Mount, for 5 x 20 mm fuse	1	F1 (ref.)	Littelfuse, etc.	111501 or equiv.
65	Hardware 2-Screw terminal Strip .375" Pitch	1	J2	Tyco Molex/Beau Augat/RDI RDI Augat/RDI	3-1437652-5 71502-C LC6-P107-02 6PCV-02 LC6-P107-02
66	Hardware 0.156" Square 3-Pin Header	1	J1	Molex	26-60-4030
67	Hardware Housing for 0.156" Square 3-Pin Header	1	J1	Molex	09-50-3031
68	Hardware Terminal for 0.156" Square 3-Pin Header	0	J1 (ref) - not supplied	Molex	08-50-0106
69	Heat Sink .720" High Rise TO-220, AAVID 590102B00150	4	Ref. CR1, CR2, Q2, Q5	AAVID	590102B00150
70	Hardware 8-32 Lock Washer	8	Ref. CR1, CR2, Q2, Q5		

FEB107-001 Evaluation Kit Parts List (continued)

Item	Description	Qty	Ref.	Vendor	Part Number
71	Heat Sink Tube, Berquist SPT400 11-25	3	Ref. CR1, Q2, Q5	Berquist	SPT400 11-25
72	Heat Sink Tube, Berquist SPT400 13.5-25	1	Ref. CR2	Berquist	SPT400 13.5-25
73	Heat Sink Twisted Fin, TO-220, AAVID 593002B03400	2	Ref. Q3, Q4	AAVID	593002B03400
74	Hardware Heatsink Assembly kit, Thermalloy 48805	2	Ref. Q3, Q4	Thermalloy	48805
75	Hardware 4-40 x .25" screws	8			
76	Hardware Ground Plate, Paradigm Metals PLATE, ref: P.O. 28678	0	Not supplied	Paradigm Metals	PLATE, ref: P.O. 28678
77	Hardware Round Aluminum 4-40 threaded 0.375" spacers	4		Digikey	J170-ND
78	Hardware 6-32 X 0.25" Screw	8			
79	PCB FAN4803EVAL P.C. Board Rev B	1		Fairchild	Rev. B
80	Hardware 4-40 x .375" Philips screws	8	Ref. Q3, Q4		

4.1 Vendors for parts

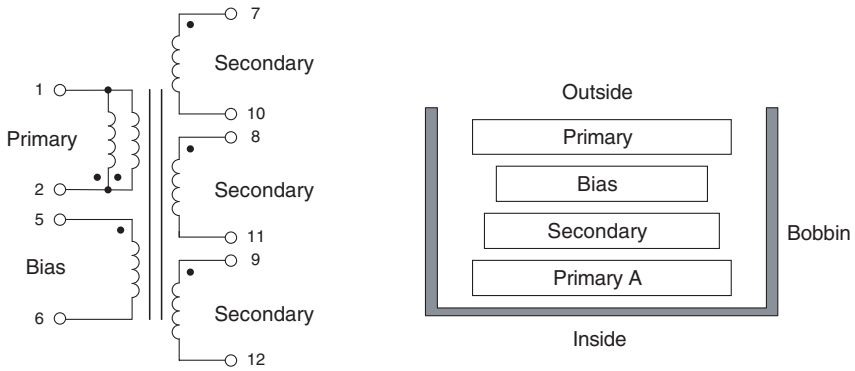
The components listed in the parts list are available from the following list:

Future Active Incorporated	(800) 723-5817
Digi-Key Corporation	(800) 344-4539
Mouser Electronics	(800) 346-6873
Premier Magnetics http://www.premiermag.com/	(949) 452-0511
Xfmrs. Inc. http://www.xfmrs.com/index.html	(317) 834-1066
Pulse Engineering http://www.pulseeng.com/default.cfm	(619) 674-8100

5. Transformer Specification

FEB107-001 T1 Forward Transformer Spec.

1. SCHEMATIC DIAGRAM. (TOP VIEW)



2. WINDING SPECIFICATION

	PIN	WIRE	TURNS
Primary A	2 → 1	28AWG	84
Secondary	7,8,9 → 10,11,12	3×1ϕ	7
Bias	5 → 6	28AWG	4
Primary B	2 → 1	28AWG	84

3. CORE & BOBBIN

CORE: EE4035
BOBBIN: EE4035

6. Printed Circuit Board

The PCB is a single layer board constructed of FR4.

6.1 PCB Silkscreen

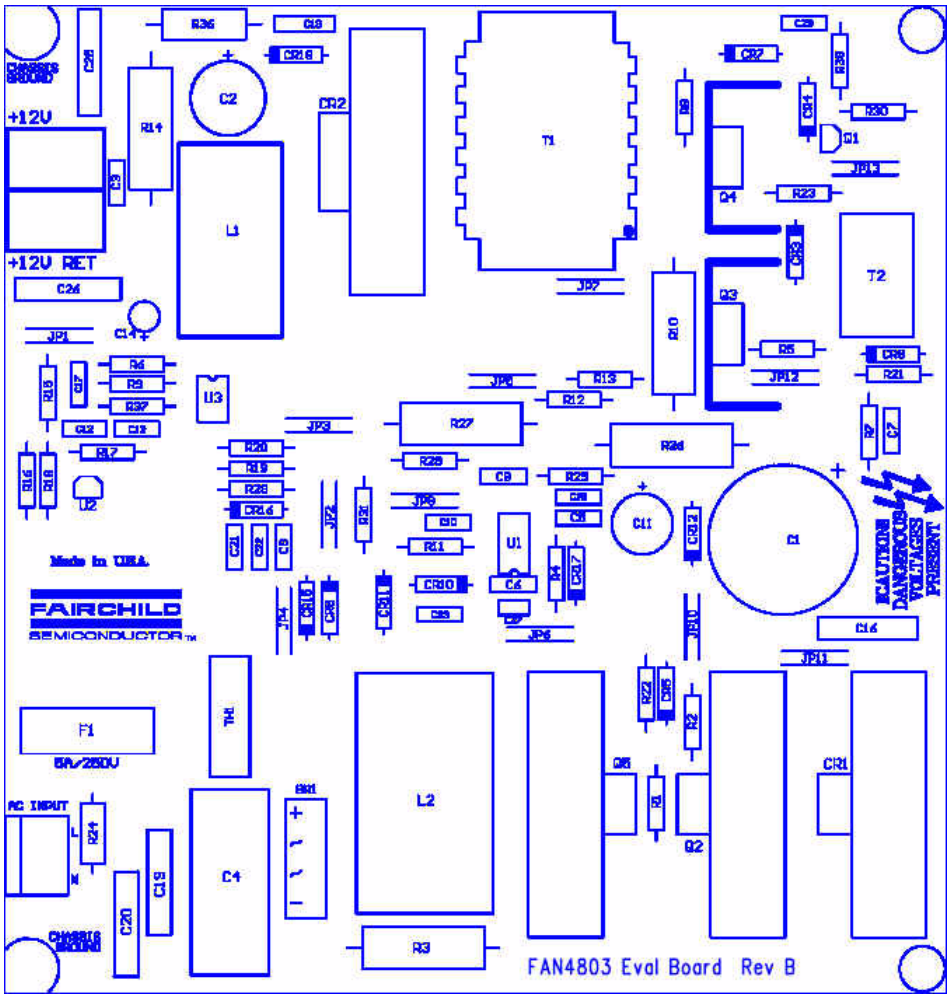


Figure 3: FEB107-001 PCB top silkscreen

6.2 Layout considerations

The FEB107-001 Evaluation board contains high impedance, low level signals and low impedance, high level circuits. Consequently, it requires extra care in component placement, grounding and PC trace routing. In order to shield low level circuits from the high level signals, the control circuits are placed in surface mount form on the bottom side of the board. Since the current sense for the FAN4803 is not differential, care must be taken to prevent large di/dt across the PCB trace joining the output capacitor and the current sense resistor. As the best place to reference the IC is at the output capacitor return potential (the most stable potential), the difference between this potential and the current sense resistor return potential must be kept to a minimum. This is accomplished by "starring" all 400V return connections to the output capacitor, and/or "starring" very low inductive/resistive paths from all power devices to the output capacitor return. Output common mode capacitors C23 and C26, along with a ground plane, have been added as a low impedance path for shunting output common mode currents back to the source through C20 and C19. Although it is not absolutely necessary for a functioning FEB107-001 Evaluation Board, it does help to reduce high frequency output noise and improve output voltage regulation.

The following list some general layout guidelines.

A. Bypass the VCC pin directly to the IC ground pin with a 1µF ceramic capacitor, located as close as possible to the IC.

B. Return all compensation components directly to the IC ground pin, keeping the lead lengths as short as possible.

C. Make sure that low level noise-free returns do not share return paths with high level, or noisy signals, *e.g.*, gate drive.

D. Isolate and or shield rapidly changing high voltage waveforms from sensitive, high impedance circuits, such as the timing capacitor, PFC current sense input, error amplifier input/output, *etc.*

E. "Star" connect all power return paths to the boost output capacitor C1.

7. Featured Products

7.1 FAN4803 Description

The FAN4803 is a space-saving controller for power factor corrected, switched mode power supplies that offers very low start-up and operating currents.

Power Factor Correction (PFC) offers the use of smaller, lower cost bulk capacitors, reduces power line loading and stress on the switching FETs, and results in a power supply fully compliant to IEC1000-3-2 specifications. The FAN4803 includes circuits for the implementation of a leading edge, average current "boost" type PFC and a trailing edge, PWM.

The FAN4803-1's PFC and PWM operate at the same frequency, 67kHz. The PFC frequency of the FAN4803-2 is automatically set at half that of the 134kHz PWM. This higher frequency allows the user to design with smaller PWM components while maintaining the optimum operating frequency for the PFC. An overvoltage comparator shuts down the PFC section in the event of a sudden decrease in load. The PFC section also includes peak current limiting for enhanced system reliability.

7.1.1 FAN4803 Features

- Internally synchronized PFC and PWM in one 8-pin IC
- Patented one-pin voltage error amplifier with advanced input current shaping technique
- Peak or average current, continuous boost, leading edge PFC (Input Current Shaping Technology)
- High efficiency trailing-edge current mode PWM
- Low supply currents; start-up: 150µA typ., operating: 2mA typ.
- Synchronized leading and trailing edge modulation

- Reduces ripple current in the storage capacitor between the PFC and PWM sections
- Overvoltage, UVLO, and brownout protection
- PFC V_{CC}OVP with PFC Soft Start

8. Resources/References

8.1 Application Notes

Application Note AN-42043 - ML4803 240W Off-Line Power Supply with PFC

Application Note AN-42047 - Power Factor Correction (PFC) Basics

WARNING AND DISCLAIMER

Replace components on the Evaluation Board only with those parts shown on the parts list in the User's Guide. Contact an authorized Fairchild representative with any questions.

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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Bottomless™	FPS™	LittleFET™	PowerEdge™	SuperFET™
CoolFET™	FRFET™	MICROCOUPLER™	PowerSaver™	SuperSOT™-3
CROSSVOLT™	GlobalOptoisolator™	MicroFET™	PowerTrench®	SuperSOT™-6
DOME™	GTO™	MicroPak™	QFET®	SuperSOT™-8
EcoSPARK™	HiSeC™	MICROWIRE™	QS™	SyncFET™
E²CMOS™	I²C™	MSX™	QT Optoelectronics™	TinyLogic®
EnSigna™	*i-Lo*™	MSXPro™	Quiet Series™	TINYOPTO™
FACT™	ImpliedDisconnect™	OCX™	RapidConfigure™	TruTranslation™
FACT Quiet Series™		OCXPro™	RapidConnect™	UHC™
Across the board. Around the world.™		OPTOLOGIC®	µSerDes™	UltraFET®
The Power Franchise®		OPTOPLANAR™	SILENT SWITCHER®	UniFET™
Programmable Active Droop™		PACMAN™	SMART START™	VCX™